Title: Visceral Geographic Insight through a Source to Senses Approach to Food Flavour

Abstract

This paper examines the experience of eating and changes to the vital materiality of food through the lens of flavour. A trans-disciplinary approach is used to gain insight from gastronomy and the neurobiology of flavour perception. Technological shifts in processing food and beverages are highlighted which show complex influences on flavour. We demonstrate the value of broadening visceral geographic understanding of the biosocial nature of flavour and the senses to answer questions about the need for new methods in visceral geographic enquiry and the role of AFNs. We propose a source to senses approach to the visceral geographies of food.

Keywords
Flavour, biosocial, alternative food movements, beer, visceral geographies

Introduction

Following the seminal work of Monteiro (Monteiro, 2009; Monteiro et al., 2010) and criticisms of what has been termed 'biological nutritionism' (Scrinis, 2013), scholarship which intersects food and health studies has sought to examine the health consequences of diets high in ultra-processed foods (Monteiro et al., 2018a). The work by Monteiro in particular has been widely taken up in the health literature, with suggestions that there are serious concerns with 'ultra-processed' products. They have been described by Monteiro as 'ready-to-consume, are entirely or mostly made not from foods, but from industrial ingredients and additives' (Monteiro et al., 2013: 22). These products are increasingly present in the global food supply, are less nutritious than minimally processed foods (Fardet, 2016; Luiten et al., 2016), and have been associated with the growing prevalence of non-communicable diet related illnesses such as diabetes and some cancers (Fiolet et al., 2018; Monteiro et al., 2018b).

Whilst there are suggestions from proponents of slow food and other alternative food movements that these alternatives might provide a more socially just and physiologically healthy choice (Goodman et al., 2012; Guthman, 2008; Sarmiento, 2017), Hayes-Conroy and Hayes-Conroy (2010a: 2963) asked whether, 'criticizing popular "tastes" for fast or processed foods as uninformed or false, alternative food movements can end up denying the biosocial mechanisms through which fast food actually comes to taste good to some people'. However, we are left with some important unanswered questions regarding the nature of those biosocial mechanisms and what leads people to have different food preferences.

More-than-representational thinking (Lorimer, 2005) provides a basis for exploring the complexity of biosocial mechanisms in food geography. Biosocial approaches are aligned with much broader questioning across the social and biological sciences of how to account for the complexity of the 'more than human' (Del Casino, 2014) and 'vital materiality' of non-human actors (Bennett, 2009). Abbots (2017) suggested that eating is a complex interplay between the body, the material stuff of food and the social (and presumably technological) meaning we give food, that combined, influence what we eat. More-than-human food geographies (Del Casino, 2014; Sarmiento, 2017) have explored the intersections between body, society, materiality, politics and environment in order to address multiple questions of social importance such as 'recent struggles over austerity, food poverty and food justice' (Goodman, 2016: 257). Equally, questions of the biosocial enter visceral geographic approaches to food geography and debates about health, health inequalities and difference (Hayes-Conroy and Hayes-Conroy, 2010a) . With visceral geography, the Hayes-Conroys take us back to the physicality of our relationship with food and the connection of this physicality to social and political processes. Whilst advancing the value of biosocial approaches to the visceral geography of food, Hayes-Conroy asks,

> What methods might be used to trace the environment into the body and the body into the environment? (Hayes-Conroy, 2017: 52).

Exposomic thinking offers insight into ways to address the Hayes-Conroy question. Prior et al (2018) have proposed the exposome as a framework in which biosocial health geography can be situated. The authors defined exposomic thinking in relation to the range of beneficial and detrimental environmental exposures that may help predict biological predispositions to health and well-being over time, including the social and political conditions that enable such exposures. For example, in recent biological/economic literature, the exposome has been employed to consider 'fast food' as a major driver of health inequalities. Prescott and Logan (2017) used exposomic thinking to consider how the accumulative exposure to 'fast food' over the life-course intersects with health inequalities. As observed in literature on health and place, non-communicable diseases (NCDs) are geographically patterned relative to socioeconomic gradients and exposure to fast food outlet clustering (Fraser and Edwards, 2010; Lamichhane et al., 2013). For Prescott and Logan, the implications are biologically significant because 'exposure' to fast food or more 'beneficial' environments makes individuals more or less susceptible to biological effects such as inflammation and oxidative stress (Logan et al., 2018). As they suggested, 'neighbourhood-level deprivation casts a long biological shadow throughout the life-course' (Logan et al., 2018: 331). An exposomic approach offers visceral geographers 'food for thought' in presenting biosocial explanations that support place sensitive research on the critical role of the environment in our experience of food, health and well-being.

Given the accumulation of ill health as evidenced in food, social and health geographies, and questions raised about the vital materiality of food and the complexity of more-than-human geographies, alternative solutions need to be considered. Championed as a potential means

of addressing social injustice and re-embedding food in place, alternative food network (AFN) practices have been critiqued for normative, white, assumptions about 'correct' ways of eating and what is 'good' to eat (Guthman, 2008; Hayes-Conroy and Hayes-Conroy, 2010a; Slocum, 2007). Such critiques sit uncomfortably with the 'social justice' focus of proponents (Goodman et al., 2012). Jessica Hayes-Conroy stated that visceral reactions 'are not natural, pre-political bodily impulses' (Hayes-Conroy, 2014: 188) thus implying that visceral difference in our experience of food needs to be acknowledged. This paper posits that food preference is a biosocial process linked to flavour and worth unpacking, not least as food preferences have formed a key theme around which critiques of AFNs have circulated. In taking a biosocial approach regarding food and flavour the authors acknowledge the varieties of ways in which the biosocial has been considered within the academic literature (Meloni, 2014; Meloni et al., 2016). Here, in taking a biosocial approach to food and flavour, the biological is situated as a partly malleable template on which social, technological and environmental factors are transformative.

Biosocial and exposomic approaches provide a means to consider visceral experience and difference as food moves from its source to our senses. The paper uses a trans-disciplinary approach to draw together significant threads from scholarship in multiple disciplines that offer insight into the role of flavour, as a biosocial process, in mediating the food exposome - body nexus. This approach offers the kinds of opportunities that Hayes-Conroy has called for to understand body – environment relationships (Hayes-Conroy, 2017).

The paper will firstly, consider the flavour, health and social justice implications associated with significant changes to the source of food. Secondly, we consider the sensing of food (from a biosocial perspective); and the impact of flavour on the body including hedonia, eudaimonia and more direct physiological processes such as appetite. Aroma especially, a vital aspect of chemosensory perception, might offer important insight to food related visceral geography including the potential for visceral inequalities. Thirdly, there will be an exploration of the impact of industrial agriculture and food production (or what is commonly referred to as 'big food') on our changed sensory relationship with food. Throughout the paper we refer to food as inclusive of beverages and eating as inclusive of drinking.

The paper will then consider the biological, technological and social processes that influence the flavour of food and beverages, within which there will be a focus on beer. The example of beer has been chosen for several reasons. Firstly, the craft beer industry is driven primarily by a desire for ongoing flavour innovation and diversity (Aquilani et al., 2015) and is thus well suited to use as case study for exploring the biosocial basis for shifts in food and beverage flavour. Secondly, it is one of the oldest and most ubiquitous processed food and beverages in existence (Nelson, 2005). We argue the case study offers insight into the complex and inter-related technological and social influences that underpin the shifts in food and beverage production, and in the case of beer over millennia, that are often un-recognised by consumers. Finally, the significant craft beer counter-movement (Cabras and Bamforth, 2016) to the industrialisation and mass production of lager beer has several themes which parallel the motivations of alternative food movements and associations with place, identity and

authenticity (Thurnell-Read, 2016). Questions regarding the health concerns associated with alcohol consumption are not the focus of this paper, although it is recognised that this is widely canvassed in the health literature (De Gaetano et al., 2016). Moreover, there is evidence that the health benefits attributed to moderate beer consumption may differ between craft and industrially produced beer (Volpe et al., 2016). However, understanding the diverse influences on food and beverage flavour and questions regarding the health aspects of alcoholic beverages is a dynamic research area. Whilst new developments in this field are ongoing the area will benefit from further research and reflection.

We argue that, recent advances in the neurology and gastronomy of flavour, flavour perception and the impact of flavour on the body (Herz, 2016; Kringelbach, 2015), represent significant advances in understanding the biosocial mechanisms that bring the (food) environment into the body. Together these trans-disciplinary considerations raise some important questions. Are we paying sufficient attention to the *sensing* of food, and has our sensory perception been transformed by contemporary food developments? Is it possible that in paying more attention to this sensing that we might find approaches through which AFNs can re-think their role in mobilising people towards a healthier engagement with food?

The source of food

Issues have emerged in the literature that underscore the need for attention on how we source food and the role that food plays in human wellbeing. 'Agro-food distanciation', which refers to the growing length and complexity of agro-food commodity chains and the loss of connection between consumers and producers (Buttel, 1998), is a key issue. The 'anonymous and homogeneous food supply' associated with agro-food distanciation has been linked to the growing prevalence of non-communicable diseases including diabetes and cardiovascular disease (O'Kane, 2016). Further insight can be derived from Patel's (2013) thesis which challenges the assumption that conventional food systems offer diversity and choice. He suggested that the range of goods is limited by the profit incentive that drives their manufacture:

> The narrow abundance of the aisles, the apparently low prices at the checkout and the almost constant availability of foods, these things are our sop. 'Convenience' anaesthetizes us as consumers. We are dissuaded from asking hard questions, not only about how our individual tastes and preferences are manipulated, but how our choices at the checkout take away the choices of those who grow our food (p. 8).

The manipulation of foodstuffs has a long history as shifts in technology have shaped the human diet. Ludwig argued that technology is a powerful actor regarding food and health, and that while we have used technology to improve food throughout history, the rate of technological change has had major implications for health. Drawing on Monteiro's re-definition of food, he detailed how the contemporary proliferation of ultra-processed products (Ludwig, 2011) has limited human diets. He suggested that such contemporary products 'may resemble natural foods, but actually represent a radical new creation' (Ludwig,

2011: 1352). Ultra-processed foods are often highly palatable but lacking in nutritional quality and flavour richness. Ludwig further described how ultra-processed foods may contain high intensity flavouring provided by salt, sugar and fat which 'may override endogenous satiation mechanisms and produce behavior akin to addiction' (p. 1353). Ludwig's argument concerning satiation and solution focussed suggestions that include public responsibility for buying less ultra-processed food intersects with the work of Carolan (2015). In attending to the 'more-than-representational' visceralities of food and through reflecting on interviews with food industry manufacturers and AFN consumers, Carolan argued that choosing alternatives to industrial food is difficult to enact if visceral experience is 'tuned' to like highly processed food; 'it is not enough to know… we also need to feel it'(Carolan, 2015: 318). If it is not enough to know, it is valuable to ask how might bodies be 're-tuned' to healthy food choices and what role might AFNs have in this process.

With these concerns about the source of food including distanciation from place, the forces that shape the relationship between producers and consumers, questions of food diversity and choice, environmental issues and the health concerns that arise from the ultra-processing of food; questions of the relevance and role of alternative food systems have been raised by scholars. In 2007, Feagan suggested that the shift to 'increasingly global-orientated food chains can be seen as a critical juncture around which most oppositional and alternative LFS discourses have coalesced in the last 30 years' (Feagan, 2007: 25). Since Feagan's paper that questions geographers' thinking about what 'local' might mean in the context of a shift to re-embed food in place, there has been an upsurge in academic discussion regarding the multiplicity of alternative food networks (AFNs) and efforts to re-localise foods including through urban agriculture and foraging (Carolan, 2015; Carolan, 2017; Goodman et al., 2012; Nyman, 2019; Tornaghi, 2014). Sarmiento (2017) stated that although questions have been raised regarding notions of exclusivity, the capacity of AFNs to transform food systems, and questions of how to maximise that capacity, AFNs and scholarship about them continue to proliferate. Sarmiento (2017: 485) further suggested the shared features of AFNs are that they 'typically seek to address ecological, social and/or political economic problems associated with conventional food systems'. Much discussion in the visceral geographic literature has focused on political agency (Goodman, 2016) and the capacity for AFNs to deliver 'good' changes to more than the largely white middle class participants (Guthman, 2008). Hayes-Conroy and Hayes-Conroy's suggested 'that eating – due to its sensual, visceral nature – is a strategic place from which to begin to understand identity, difference and power' (Hayes-Conroy and Hayes-Conroy, 2008: 462). In her call for new methods for the practice of visceral geography Hayes-Conroy noted that her work in this field has highlighted 'interconnections between mind/body, discourse/feeling, immaterial/material, social/biological and self/environment' (2017: 52). She additionally stated:

> I want to consider how visceral methods can attend to broader biological and ecological realities, as they are central to both bodily experience and political situatedness. (Hayes-Conroy, 2017: 52).

The centrality of the 'bodily experience' of food owes much to our sensory ability to experience and flavour, the biosocial nature of that experience, and the ways in which it influences food preferences. These concepts are discussed in the following section.

Flavour, viscerality, the pleasure of eating, and well-being

Visceral geographies take us back to the embodied and deeply personal experience of food and its politics, and is a move away from the tendency to theorize food systems 'without a body' (Brooks et al., 2013). Visceral approaches are concerned with 'the sensations, moods, and ways of being that emerge from our sensory engagement with the material and discursive environments in which we live' (Hayes-Conroy and Hayes-Conroy, 2010b: 334). Concurrent with the sensory turn in food geography, other social science fields are increasing attention to processes related to the body's sensory engagement with place including haptic touchy-feely approaches to smellscapes and our sensuous experiences of place (Henshaw, 2013; Paterson, 2009; Pink, 2015; Rodaway, 2002). In addition to this sensory turn and other more-than-representational approaches in geography, there has been a transformation of understanding in how food is sensed in the biological and physical sciences, industry and gastronomy. Insight from these recent understandings in visceral geography and biology, which relate to the material stuff of food and the mechanism of sensing, may contribute to a broader biosocial understanding of food preferences and foodscapes.

Addressing problems concerned with differences in language usage between the various disciplines might be a useful starting point. Confusion has been created by the range of meanings implied by the word taste both within the geographic literature and between the social scientific and biological literatures. In the social science literature, taste has been equated with gastronomic preference (as in Bourdieu's sense that taste expresses class and/or culture based distinctions) (Bourdieu, 1984). More importantly, at visceral and sensory levels, taste is often used in the geographic literature in a way which confuses it with the concept of flavour as used in the biological sciences. Using taste to imply an overall perception of food flavour may create confusion in discussions of the viscerality of food. In the scientific literature, taste is commonly used as a specific reference to the detection of sweet, sour, bitter, salty and umami compounds by taste receptors, primarily on the tongue. Spence et al (2015) further suggest that specific taste qualities such as sweetness should be referred to as elements of flavour. Thus, flavour includes taste but is a larger experience that is currently understood as the culmination of sensory experience in relation to food and eating.

However, in common usage 'taste' implicitly refers to the overall experience of food which encompasses the full range of sensations associated with eating (i.e., this food tastes good). In the sensory literature this meaning of taste is referred to as multi-modal flavour perception which is understood to involve a fusion of sensory inputs that include taste, smell, trigeminal nerve stimulation, sound, visual cues, temperature, and texture that are unified at a neurological level during the act of eating (Auvray and Spence, 2008). The use of the word 'taste' can therefore be prone to being lost in translation between disciplines. In this paper,

the term flavour refers to 'multi-modal flavour perception' and is used as a more encompassing descriptor than 'taste'. These differences in terminology and meaning need to be understood by visceral geographers in order to develop interdisciplinary research on food and eating. In other languages there are words that more explicitly refer to both taste and aroma perception including goûter in French (Montanari, 2009: 93), schmecka in the Austrian region of Vorarlberg (Mann and Mol, 2018) and schmöckt in Swiss German (author's own research).

However, it is important to recognise that flavour perception is a biosocial experience and the flavour experience depends on the characteristics of foodstuffs that are perceived differently depending on individual capacity, contexts that modify that experience, and on the social and cultural patterns associated with eating. As Kerner and Chou (2015: 1) suggested, commensality, or eating together at the same table, is 'undeniably one of the most important articulations of human sociality'. Howes's (2005) work has additionally demonstrated that sensory perception is deeply cultural and political and not simply a matter of cognitive processes or mechanisms. The insight from Hayes-Conroy and Hayes-Conroy that, the 'ingestion' and experience of food is not able to be reduced to mere biological or chemical equations (Hayes-Conroy and Hayes-Conroy, 2010a) is valuable.

An examination of the role of smell in flavour perception and the neurology of that perception will provide more insight into the biosocial reasons for why people have different visceral engagements with food and interaction with foodscapes. Smell is regarded as the most important contributor to the flavour experience (Kringelbach, 2015) and current understandings of that contribution provide insight into visceral difference. The contribution of smell to flavour perception has unique role when compared to the contribution of the other senses to our experience of food. Firstly, our olfactory mechanisms have the capacity to differentially (and synergistically) detect the vast range of volatile organic compounds found in foods. Thus, to a large extent, smell governs our experience of the 'flavour' of food. As Charles Spence suggested:

> …the pleasure, all the interesting dimensions of what is commonly called taste, the meaty, the floral, the fruity, the herbal, the citrus, the burnt, all derive primarily from the contribution of olfaction (Spence, 2015: 7).

At a neurological level, the sense of smell is processed and experienced differently to the other senses and this needs to be understood in two important ways. A distinction is made between orthonasal and retronasal olfaction (Shepherd, 2006). Orthonasal olfaction is the process of sniffing whilst retronasal olfaction is induced when food volatiles are forced from the oral cavity to the nose through the process of eating. The smell experience from sniffing often provides (as in the case of coffee) a different visceral experience to that experienced in the process of eating or drinking (retronasal) where the experience is combined with the other components of multi-modal flavour perception (Kringelbach, 2015). Furthermore, there is evidence that the two olfactory systems are processed differently at a neuronal level (Bojanowski and Hummel, 2012).

Additionally, the neuronal processing of olfactory experience bypasses the thalamus to connect more directly to areas of the brain that process emotion, associative learning and memory (Herz, 2016). 'Smell memories' are more 'emotional and evocative' than memories governed by other sensory inputs (Herz, 2016) and as Herz stated in her recent review of smell literature, 'odor-evoked memories are exceptionally viscerally involving because the neuroanatomy of olfaction has a privileged and unique connection to the neural substrates of emotion and associative learning' (Herz, 2016: 2). The link of flavour perception with memory and emotion has important implications for how people make, or are able to make, food choices. At an experiential level, smell has been found to be malleable. That aroma perception is amenable to change, is demonstrated for example, through results from the burgeoning new interest in olfactory training for both healthy populations and those with smell loss (Drews and Hummel, 2016; Mori et al., 2015). Hedonia research (the study of pleasure), explores the neurological pathways that link smell to memory and emotion (Kringelbach, 2015). If smell is the substrate of emotional memory then the importance to those deeper connections to food is not trivial and the link to memory and emotion is utilised by food companies and sustainable food producers to promote sales (Carolan, 2015).

Flavour based visceral differences in relation to food are apparent across the life-course and in illness. Flavour perception is a very individual experience (Goldberg et al., 2018) which is overlaid by shifts in the sensing of food. To briefly summarise, sensory perception begins in the third trimester of pregnancy; food preferences are learned through sensorial exposure in infancy and early childhood; in adults evidence exists that flavour characteristics of food impact appetite and calorie intake; and in ageing the loss of chemo-sensory capacity can lead to the loss of pleasure in eating (Boesveldt et al., 2018). Illness adds further complexity. Recent research has suggested a link between the volume of the olfactory bulb and major depressive symptoms (Negoias et al., 2016). The relationship between smell function and depression is thought to work in two ways, through reduced attention to smell in depressed subjects, and due to reduced olfactory function leading to depression (Croy and Hummel, 2017). For people with 'altered eating' difficulties resulting from diminished multi-modal sensory experience, the impact can be socially isolating and involve an almost unbearable loss of pleasure and interest in food and eating (Burges Watson et al., 2018). The loss of pleasure in food may also be a temporary experience in those with normal function, for example, in the use of various drugs (Wang et al., 2017), or when a common cold all but obliterates the full experience of 'flavour'. Food under such circumstance, can appear dull and bland (Thiermann and Buchbauer, 2017).

There is evidence that sensory experience, including flavour perception, can be influenced by environmental factors and diet. Hoover's paper on 'sensory inequities' (Hoover, 2018) raised important questions about visceral difference that is relevant to the experience of food flavour. This work, which has a focus on olfaction, considers how modern lifestyles and pollution can impact on human sensory perception. Noting a strongly indicated relationship between pollution and the potential for smell dysfunction, alongside socio-economic differences in exposure to air pollution, Hoover argued that sensory abilities need to be

framed within questions of inequity and injustice. Her work exposed an aspect of how visceral difference is more than human as pollution has the capacity to impact sensory experience. In relation to eating, Stevenson et al (2016) found evidence for poorer odour identification abilities in habitual consumers of a 'western style diet' compared to 'healthier' diets. These examples offer insight into the complexity of the food exposome and the biosocial factors which underpin visceral difference. This reinforces Hayes-Conroy's concern not to universalize visceral experience (Hayes-Conroy, 2017), not least because of the different environments in which people live. However, as Prior (2018) noted, exposomic thinking is concerned with both detrimental and beneficial exposures. Improvements in smell function can be achieved through olfactory training for those with smell loss (Konstantinidis et al., 2016; Pekala et al., 2016).

The contribution of variations in individual biology, the food exposome and the environment, to flavour based differences in the visceral experience of food congrues with recent discussion about what contributes to some people having better olfactory abilities (Majid et al., 2017). Previously it was thought that humans had a poor sense of smell but this is now regarded as a 19th century myth (McGann, 2017). Rather than focus on dysfunction, Majid et al (2017) reviewed the scientific literature to consider why some people are able to 'smell better' than others. The authors concluded that,

> to be a better smeller, one must inherit the right biology, live in the right environment, or have the right experiences. Although not all of them are available to each and every one of us, some are, and this is positive news (Majid et al., 2017: 421).

This implies there is a capacity for people to expand their olfactory ability given the right circumstances. The paper highlights active training (e.g. wine experts) and what is termed 'mere exposure' training. In the latter, increased exposure, without specific training, to a particular odour can increase sensitivity to that odour and possibly improve detection of other odours. Given that olfaction is such an important part of flavour perception, the observation that our sense of smell can be enhanced may have important implications for potential shifts in our visceral relationship with food.

Hedonia research, or the scientific study of pleasure, has provided new insight into the 'hedonic potency of odours' (Kringelbach, 2015) and the link between pleasure and well-being (Stark et al., 2018). The experience of pleasure is generally regarded as being a critical part of human wellbeing (Zou et al., 2018) and the multisensory experience of food is one of the main avenues for the experience of pleasure (Kringlebach, 2015). The potential link between the experience of pleasure from food and overall wellbeing is an additional consideration. The distinction between 'hedonia' (a positive effect) and 'eudiamonia' (the feeling of a life well lived) has provided a new way of thinking and accounting for the importance of pleasure (as an interplay between hedonic and eudaimonic elements) to human health (Kringelbach and Berridge, 2017).

An understanding of the neurology of smell and pleasure is also changing 'high end' cookery through modernist cuisine approaches and in the novel research area of neurogastronomy (Herz, 2015). For example, Grant Achatz, founder of the acclaimed restaurant *Alinea* in Chicago, uses smell memories to invoke powerful emotions amongst his diners. One of his signature dishes involves burning oak leaves served alongside a dish of pheasant. The smell of the oak leaves takes the diners in his American city back to childhood memories and the wonder of the fall. He notes the dish can make diners cry (Stein, 2010). That such a foodstuff can generate such pleasure for the eater helps explain the popularity and interest in 'modernist' cuisine and the science of how food is sensed. While there is a complex history to developments in 'molecular gastronomy', 'progressive cuisine' and its allies, modernist cuisine advocates share, as Barham et al suggest, a concern with the 'scientific study of why some food tastes terrible, some is mediocre, some good, and occasionally some absolutely delicious' (Barham et al., 2010: 2315). Clearly, smell is an important aspect of the viscerally based perception of food, having a specific neurology closely linked to pleasure.

Visceral geographic enquiry acknowledges the role of flavour (sometimes referred to as 'taste') regarding how we make food choices (Hayes-Conroy and Hayes-Conroy, 2010a). Indeed, Hayes-Conroy and Hayes-Conroy (2010a) suggest it may be valuable to understand why foods feel differently in different bodies. Insight from neurology and gastronomy offer new approaches to addressing these important questions being raised by visceral geographers. However, how we perceive flavour has much to do with the food we are eating.

Big Food and ultra-processing

'Big food' has been widely used as shorthand for multinational food and beverage companies with 'huge and concentrated market power' first noted in developed countries, but increasingly influential across the globe (Stuckler and Nestle, 2012). What is consumed globally is not simply regarded as a concern about expansion, but also about the changing nature of food and beverage products. Tracing the most recent technological shifts to the 1980's, Monteiro and colleagues noted the rise of 'ready to consume processed products' that are characteristically high in salt, sugar and fat (Monteiro et al., 2013). Many public health advocates have argued that these changes can be variously mapped to the increase in ill-health across the planet (da Costa Louzada et al., 2015; Ludwig and Friedman, 2014; Moodie et al., 2013) . The links between the consumption of ultra-processed foods and health conditions such as obesity and metabolic syndrome have been widely studied (da Costa Louzada et al., 2015; Tavares et al., 2012). The shifting nature of food has led to a popular definition of many processed products as 'food-like substances' (Pollan, 2006).

The reclassification of foods by Monteiro and colleagues, initially into three groups (Monteiro, 2009; Monteiro et al., 2010), which paid attention to the level of industrial processing and relative health value, has spawned important discussion in the academic literature. The Monteiro group's most recent classification for foods is a four tier system (Monteiro et al., 2019). NOVA (*a name, not an acronym*) group 1 food stuffs are unprocessed

or minimally processed foods where the aim is to increase the shelf-life or broaden the food's usage. NOVA group 2 foods are processed culinary ingredients extracted from group 1 foods or nature, such as oils and salt, which are used in food preparation. NOVA group 3 foods are obtained through industrial processing by adding group 2 to group 1 foods with the aim of preservation or improving the sensory qualities of the foods. Examples included cheeses, bread and beer (Monteiro et al., 2019) (for beer, see supplemental table S1). NOVA group 4 or 'ultra-processed' foods are formulations of multiple extracts and sometimes include chemically modified ingredients, that are made palatable with additives.

Since its formulation, the NOVA classification system has been used worldwide to describe dietary patterns in key populations, to assess socio-economic distributions of ultra-processed foods, and to examine the consumption of particular dietary components such as sugar (Monteiro et al., 2018a). Monteiro's taxonomy has additionally generated research enterprises that track shifts in the levels of processing employed by Big Food, and wider scrutiny of agro-industrial food provisioning (Global Panel on Agriculture and Food Systems for Nutrition, 2016). Overall, the use of the classification system has generated growing concerns that globally, fewer consumers are eating minimally processed food whilst increasing their consumption of ultra-processed food (Monteiro et al., 2018b). However, there is wide variability in the geographic and socio-economic patterning of ultra-processed food consumption. For example, the contribution of ultra-processed products to household food purchases in Europe has been estimated to vary between 10·2 % in Portugal and 50·4 % in the UK (Monteiro et al., 2018b).

Monteiro's classification and overview of ultra-processing has re-framed the capacity for public health to question agro-industry's drive to produce products that are

> designed to create durable, accessible, convenient, attractive ready-to-eat or ready-to-heat products… formulated to reduce microbial deterioration ("long shelf life"), to be transportable for long distances, and to be extremely palatable ("high organoleptic quality") and often to be habit-forming (Monteiro et al., 2010: 2041).

However, Monteiro's assertion that highly processed food is extremely palatable with high organoleptic quality needs to be questioned. Organoleptic quality could refer to the taste and aroma sensory properties of food that are available to multi-modal human flavour perception. If food with a high organoleptic quality is defined, for example with regard to aroma, as containing a highly diverse range of flavour molecules that provide a rich hedonic experience for the user, then it does not follow that high palatability can necessarily be equated with organoleptic quality.

The palatability of less nutritious food should be of major concern to people who are concerned with either the health implications of ultra-processed food or the capacity of consumers to source more nutritious food with good hedonic potential. Mouritsen (2016) commented that ultra-processed foods are typically made more palatable by *shifting* the balance of salt, sugar and fat (most commonly upwards). For example, the addition of salt to

processed food has long been controversial regarding the impact of a high salt diet on health. Apart from preservative and processing functions, salt is often added to processed food for flavour enhancement. Besides adding saltiness, the flavour functions of added salt include masking metallic or bitter flavours, flavour enhancement of existing flavour volatiles, and improved mouthfeel (Hutton, 2002). Whilst ultra-processing may reduce the natural flavours and nutrients that may be present in whole foods, the addition of salt and other flavour enhancers may give the food high palatability whilst it is lacking in flavour complexity. Mouritsen (2016) goes further and states that, changes to food are 'reasons why our brain, the flavor of our food, and hence our health are under siege'. (p. 1)

Additionally, it has been argued (Scrinis, 2013), that there are problems with the nutritionist approaches that have underscored nutrition science research, dietary advice and other policy initiatives since the late 19th Century. Nutritionism, Scrinis suggested, is an ideological discourse with a reductive focus on the healthfulness and nutritive values of foods over other values related to health and well-being. The focus on nutrition as the basis of health in relation to ultra-processed or minimally processed foods or beverages, continues in this vein, avoiding crucial aspects of sensory perception and pleasure (both hedonic and eudaimonic). Sensory science and hedonia research may offer a counter-hegemonic discourse to the ideology of nutritionism. Clearly, understanding the complex technological and neurological factors that make food differentially palatable and / or delicious is important for critical scholarship in visceral geography.

Twentieth Century Changes to Flavour Landscapes

In the Western world, there have been changes to both the intensity and diversity of the flavour landscape during the 20th century. These changes are complex but often there have been flavour losses in foods is a result of changes to the genetic varieties of fruits and vegetables, picking maturity and post-harvest handling (Klee, 2010; Baldwin et al. 2007; Kader, 2003); and food processing (not just ultra-processing) during the 20th Century (Carolan, 2005). However, it would be a mistake to reduce the changes to flavour landscapes to the specific scientific and technological shifts that have changed food itself rather than examine the processes that underpin how consumers come to prefer certain foods. Carolan's examination (2005) of the tacit knowledge inherent in food systems through interviews with industry representatives provided insight into the marketing and food formulation processes through which bodies have been 'tuned' to processed foods.

Changes to beer flavour during the 20th century provides insight into the biosocial factors which have influenced a reduction in flavour richness and diversity. Beer made predominately from malted barley, defined by Monteiro's group as a NOVA group 3 processed beverage (Monteiro et al., 2019) , is one of humanity's oldest processed food technologies with evidence for production that dates back several thousand years in the Near East and China (McGovern et al., 2004; Nelson, 2005; Wang et al., 2016). Whilst barley-based beer is the focus of this discussion, it should be noted that there are other traditional grain-

based beer forms. In the Global South these include sorghum beer in Africa (Rogerson, 2019); and corn beer in Central and South America (Mena et al., 2016).

There are numerous accounts in the geographic literature that evidence a homogenisation of Western barley-based beer production that resulted in reduced intensity and diversity of the flavour of beer. Given that there is a countervailing craft beer movement motivated by improving the flavour of beer (to be discussed in the next section), unpacking the reason for homogenisation may provide insight into the biosocial reasons for the loss of flavour in foods more broadly. Key reasons for the standardisation and consequent losses of diversity in beer flavour have been variously discussed in the literature (Cabras and Bamforth, 2016; Choi and Stack, 2005; Dighe, 2016; Poelmans and Swinnen, 2011). By the 1980s, following a lengthy period of 20th century national consolidation, mainstream beer had low bitterness levels and little variety in flavour. Mainstream American beer in particular has been described as bland (Dighe, 2016; Choi and Stack, 2005). Consolidation of the industry additionally led to production by a fewer number of brewers. Between 1900 and 1980 the number of breweries in the UK was reduced from 6447 to 142 and in the US from 1806 to 48 (Cabras and Bamforth, 2016). Declines in the number of breweries were also observed in Germany and the Netherlands but not in Italy where the number of breweries was already low (Garavaglia and Swinnen, 2017). A similar pattern was observed in Belgium with a reduction from 663 to 123 breweries occurring over the period 1950 to 1980, although in the Belgian example a more diverse range of beers continued to be produced (Poelmans and Swinnen, 2011).

The spread of transnational brewing companies, which began in the 1960s but progressed more rapidly in the 1990s and 2000s, additionally contributed to standardisation and homogenisations of beer styles (Garavaglia and Swinnen, 2017). In 2014 half of all global beer sales were controlled by four large companies whose major products were pale lagers (Howard, 2014). In the US 90% of beer production is controlled by two large companies, a reduction from 48 major brewers in 1981 (Lynn, 2012). Lynn commented that this consolidation threatens variety, quality and the management of the distribution process. The merger of Anheuser-Busch InBev and SAB Miller further consolidated the industry and has attracted interest from researchers. It was estimated that the new company will have a market share of one third of worldwide beer sales (Collin et al., 2015). Consolidation of the beer industry is ongoing (Howard, 2014) with a range of potential consequences for the flavour and place-based aspects of beer production. Some larger companies which have bought up smaller traditional breweries have maintained the brands but are now brewing them off site (Collinson and Macbeth, 2011). Arguably the traditional flavour may have been maintained but with consolidation, the brewing is distanced from place.

Technological innovation, cultural shifts and agronomic factors since the 19th century have also influenced beer production, flavour and diversity. In particular the discovery of 'bottom fermentation' (lager beer) and associated technologies such as refrigeration, which led to a clearer more storable beer, allowed the domination of lager beer in the international market (Poelmans and Swinnen, 2011). Key related technologies highlighted by Poelmans and Swinnen included isolation of the specific yeast strain responsible for fermentation which

allowed the spread of lager production to other breweries; the invention of the steam engine which facilitated refrigeration; and a method for the mass-production of glass bottles that allowed wider distribution. In the US, an even lighter style came to be the beer of choice. Prohibition from 1919-1933 led to the closure of many breweries (Clemons et al., 2006). Two world wars, severe drought in the 1930s and periods of either grain rationing or limited availability of barley for brewing all impacted the move to a lighter style of beer (Poelmans and Swinnen, 2011). The consequent use of cheaper alternative grains to supplement barley (adjunct brewing) for beer production led to lighter lager styles in the US and this became the beer of choice for most consumers (Poelmans and Swinnen, 2011). It has been suggested that US beer styles were also influenced by the temperance movement (Dighe, 2016). Clearly, there were multiple technological, cultural and agronomic factors associated with the trend towards the reductions in intrinsic flavour and sensory qualities within the beer industry.

Maintenance of beer production lacking flavour diversity has been described as a form of industrial path dependency with behavioural lock-in by consumers who favoured their own national brands (Choi and Stack, 2005; Stack et al., 2016). This notion of a lock-in effect is also raised by Carolan (2015) where it was suggested that consumers have become locked-in to eating processed foods. Related observations have also been made regarding research into heirloom tomatoes (Joseph et al., 2017) where it was suggested that a marketing landscape based on visual appeal may have led to an inability of the consumer to make choices based on flavour. Overall, the reasons for the homogenisation of beer flavour, provide insight into the perception and/or visceral process of identification through which craft industries laid claim to the subsequent re-emergence of quality and diversity in beer flavour.

The re-emergence of flavour and its relation to place

In beer production, whilst there has been a consolidation of the major brewers globally, a new craft beer and/or micro beer industry has emerged since the 1980s as both the upholders of tradition and innovators regarding increases in flavour intensity and diversity (Cabras and Bamforth, 2016). A recent UK based paper highlighted that the craft brewing industry aims to produce 'a high level of diversity of flavoursome beers' (Danson et al., 2015: 141*).* The new interest in traditional ales and other non-lager beers has been referred to as a 'return of the monasteries' (Poelmans and Swinnen, 2011: 14), which were the 'centres of the beer economy in the early middle ages' (p. 1). In 1996 craft brewers held less than 3% of the market share in US beer production (Bastian et al., 1999). In 2016 it was reported that craft beer makes up 12% of the US beer market and that it is expected that the global market share will be 10% by 2020 (Cardello et al., 2016). US craft beer sales in 2016 were estimated to be worth 23.5 billion USD equating to a 21.9% dollar value market share (Cohen, 2016). The trend towards an increased diversity in production is evidenced by an increased number of breweries in multiple countries (Garavaglia and Swinnen, 2017). Large increases in the number of breweries during the latter part of the 20th century were apparent in the UK, USA, and the Netherlands from the mid 1980s onwards. In Australia the number of

microbreweries increased from 3 in 1985 to 358 in 2015 (Garavaglia and Swinnen, 2017). In Italy, which has a reputation as a wine drinking nation, an increase in breweries began at the end of the 1990s. However, the emergence of a craft beer industry has not been limited to the Global North. Since 1994 a craft beer industry has emerged in South Africa with parallels to that which has occurred in the Global North (Rogerson, 2016). In Latin America mass-produced US style lagers predominate (Toro-Gonzalez, 2018) although there is an emerging Western style craft beer industry (Mena et al., 2016; Toro-Gonzalez, 2018).

Evidence exists that place is emerging as an aspect of the craft brewing industry. The desire for locally produced ingredients for use in craft beer is leading to the re-emergence of regional small-scale malt houses in the US (Brouwer et al., 2016; Knudson, 2014). In the Nordic region a model for the development of small scale malting facilities was developed (Olsson et al., 2009). The importance of beer in British culture and the link to place and identity in the UK and elsewhere was recently discussed by Thurnell-Read (2016). The relationship between craft brewing and sense of place is a strong theme within cultural geography (Flack, 1997; Hede and Watne, 2013; Schnell and Reese, 2003). In particular the emergence of craft brewing and its subsequent increase in market share since its origins in the 1980s (Bastian et al., 1999) has provided fertile ground for this place based examination. However, flavour is not always identified as a key aspect in understanding the cultural geography of beer (e.g. some papers highlight place but not flavour). Sense of place has been identified as a key aspect in the marketing of craft beer (Hede and Watne, 2013).

Science and technology have been critical to the improved flavour outcomes in craft beer. The final flavour of beer, moderated by the level of carbonation, is achieved through contributions from hops, malt, various adjuncts, the fermentation process, and sometimes in craft beer the addition of non-conventional flavour materials. A clearer understanding of the major flavour and aroma volatiles has been an ongoing research task. There is progress in understanding the role of yeast in the biosynthesis of esters, higher alcohols and off-flavours during fermentation (Pires et al., 2014). Further flavour contributions, and consequently a range of flavour synergies and complexity, are provided through hop flavour technology and varietal selection (Almaguer et al., 2014; Schönberger and Kostelecky, 2011; Takoi et al., 2016). An Australian hop breeding program at the University of Tasmania in a collaborative partnership with Hop Products Australia (McAdam et al., 2014; Whittock et al., 2013; Yan et al., 2017) has led to new Australian hop varieties with unique flavour and aroma characteristics.

The focus on hops has added new dimensions to the flavour possibilities in beer including through the use of hop extracts, late-hopping and dry-hopping**.** One of the most successful companies that started commercial life as a micro-brewery is Sierra Nevada (Grossman, 2013). Cabras and Bamforth (2016) highlighted the importance of a big hop-derived flavour philosophy in the development of the Sierra Nevada brand. They additionally stated that many of the early micro-brewers in the US started as home brewers who were enabled by changes to the regulatory environment in 1979 which legalised home brewing which had been banned since prohibition (Cabras and Bamforth, 2016).

The importance of insights regarding multimodal flavour perception, differences in individual flavour perception capacity, the physico-chemistry of the behaviour of flavour volatiles in the beer matrix, and flavour volatile detection are now being considered by scientists in order to understand beer flavour (Clark, 2011). In particular, recent advances in analytical chemistry (Andrés-Iglesias et al., 2015) have facilitated these investigations. Individual breweries have also embraced new technologies. Sierra Nevada has a focus on quality and consistency and uses analytical equipment rarely found in beer laboratories, including Gas Chromatography - Olfactometry for flavour analysis (Cabras and Bamforth, 2016). The analytical opportunities available to brewers may assist in the development of diverse flavour outcomes.

Malt, the other key ingredient in beer making, has been under-explored with regard to flavour. Understanding the malt derived compounds produced during mashing (the early stage of beer making that breaks down carbohydrates and proteins to simple sugars and amino acids) and how they interact with other compounds and enzymes both during fermentation and in the finished beer may provide further flavour opportunities. Malt contains a range of monophenols, which are important contributors to the flavour of beer (Sterckx et al., 2011). Understanding the range of monophenols and their metabolic precursors in barley and malt offers further opportunities for product differentiation as producers could match hops and malts in a way that creates flavour synergies. There is potential for the enhancement of malt flavour in beer through the release of precursor flavour compounds bound to sugars and this has been observed in a preliminary study (Jin and Rogers, 2000). The polyphenol catechin glucoside was found to increase significantly during the malting process (Friedrich and Galensa, 2002) providing evidence that flavour compounds present in barley could become bound to sugars during malting. Understanding the range of glycosidic precursors in malt would provide opportunities for both flavour differentiation and increased intensity of the flavour contribution from malt. These examples demonstrate that flavour is not a ‘fixed’ property and that innovations in science or technology can open up new avenues for continuous evolution and redefinition of the flavour of beer.

In summary, from the early part of the 19th century opportunities existed for consolidation of the brewing industry that, when considered alongside technological discoveries and cultural factors, resulted over time in losses in local identity and flavour diversity, alienating consumers from a broader experience of flavour and place. This period has been followed by a more recent re-emergence of flavour and place in craft and micro brewing as being important to both producers and the consumer. There are new insights into the complexity of beer flavour and the opportunities for creating beers which provide both flavour diversity and opportunities for place-based differentiation through varietal choice and local brewing techniques that might create regional characteristics. Given concerns regarding the health aspects of alcoholic beverages alcohol-free beers have also been part of new developments in brewing. New technologies for producing flavoursome low alcohol beers are being considered (Loredana et al., 2018) and the possibility of using dry-hopping to add flavour to

alcohol-free beers and other beverages has been examined as a response to health concerns (Hagemann et al., 2016; Hagemann et al., 2017).

The emergence of the flavour and place-based craft beer industry was partly driven by early innovators such as Grossman at Sierra Nevada and by changes in the regulatory environment. However, the role of science and technology in providing new flavour opportunities cannot be underestimated. A more refined science, which gives insight into both human flavour perception and aroma biosynthesis, has provided opportunities for increasing the intrinsic flavour diversity of beers. Overall, being able to taste your local brew may be more possible as a result of technological innovation. Ironically then, technological discovery has played a role in both the reductions in flavour diversity and the late 20th century re-emergence in some contexts and places.

The observations relating to beer resonate with the arguments of Ludwig (2011), Carolan (2015), Monteiro (2013) and others that technology associated with agro-industrial food provision has fundamentally altered the intrinsic qualities of food and beverages, and our ability to perceive the significance of the differences. However the widespread alienation from a diverse flavour experience in the beer industry was not a planned assault on our senses by industry but a result of a series of complex social and technological factors that has previously been described as an example of path dependency and behavioural lock-in (Choi and Stack, 2005; Stack et al., 2016). Whilst Feagan (2007) has argued that big food was a critical juncture around which AFNs crystallised similarly, what we might call 'big beer' through a locked-in focus on the production of lager beer fomented the craft beer revolution and the resultant production of flavour diverse beers. Importantly, the beer example shows that industry transformation is possible through a focus on flavour.

Sensing the future – engaging with food through flavour?

This paper highlights the possibility that a focus on flavour might be a mechanism for understanding biosocial mechanisms associated with food preferences. This focus gives the possibility to explore key questions raised by visceral geographers relating to mobilisation and the mechanisms of relationship between food and the body. In the foundations of visceral geography Hayes-Conroy and Martin (2010) highlighted the importance of paying attention to visceral feelings in encouraging participation in the slow food movement. However, in the further development of visceral geographic thinking, Hayes-Conroy (2017) is now asking for methodologies that explore the interface between the vital materiality of food and the body. From a flavour viewpoint, there are specific biological processes which allow people to engage with food and food systems but these are modified and / or constrained by social experiences which alter our learned and emotional engagement with particular foods.

Important biosocial elements regarding the flavour of food include the link between flavour and subjective wellbeing and visceral differences regarding the flavour experience of food.

The contribution of a rich flavour experience, which includes the complex array of flavour elements that constitute multi-modal flavour perception rather than simple palatability, to the pleasure of eating and associated wellbeing offers a new layer of investigation for geographers. Wellbeing is now widely recognised in the geographic literature as a potential contributor to health (Smith and Reid, 2018), but given the links between food and health following Monteiro's seminal work (Monteiro, 2009; Monteiro et al., 2010; Monteiro et al., 2013), the link to food flavour deserves further examination.

Visceral difference and visceral inequality are key aspects of the experience of flavour. People do not 'sense' food in the same way due to biological (e.g. altered eating; differential abilities to 'smell'), environmental (e.g. pollution, experience of odours, training), socio-economic and cultural factors. Socio-economic differences provide people with different flavour experiences through exposure to ultra-processed, fast food, AFN, modernist cuisine and/or other foodscapes. Given the health issues associated with ultra-processed foods and the juxtaposition with healthier, more flavoursome options, it is not difficult to understand how new 'visceral inequalities' may be emerging across the food chain. Given the dominance of ultra-processed foods in many countries, could flavour be a motivating force for mobilizing participation in AFNs without the 'normalizing of experience' concerns raised by Guthman (2008) and Hayes-Conroy and Hayes-Conroy (2010a).

There is evidence that suggests flavour may be important to participation in alternative food movements, choices and thinking about food in relation to place. The study by McLain and colleagues on the motivation to forage free 'wild foods' in the city highlighted flavour as key reason to source wild foods and as a source of great pleasure (McLain et al., 2014). At the other end of the economic scale, molecular gastronomy is concerned with 'deliciousness' (McGee, 1984). Whilst, it is ironic that only the very rich could afford a place at the table of Rene Redzepi's Michelin starred restaurant Noma in Copenhagen, the foods themselves are 'foraged' for free because, as expressed by Redzepi's open source *Nordic Food Lab*, it is through the geographic exploration that a sense of place might be gained. They suggest that by acknowledging geography as the foundation of gastronomy there is freedom to explore local foods which, they argue 'says something about us and imbue foods with a connection to this place and time' (Nordic Food Lab, 2016). Sourcing for the senses may reconnect consumers to the flavour of place with or without political or economic motivations to do so.

Genetic differences contribute to the biosocial nature of flavour perception exist in relation to food and sensing. A genetic basis for differences in ability to detect flavour volatiles through smell is a recent hot topic in flavour science (Logan, 2014; Silva-Teixeira et al., 2016). Logan argues that these differences allow a personalised 'perception of our environment' (Logan, 2014). As an example, the low odour threshold odourent, beta-ionone, which is a major component of the Boronia natural extract used to enhance berry fruit flavours in foods (Cooper et al., 2009) is known to have low sensitivity in some sections of the population (Plotto et al., 2006). This observation that some people are unable to smell beta-ionone is now known to have a genetic basis (Jaeger et al., 2013).

Aside from some genetic differences, there is considerable evidence from cultural studies that aroma perception has a social component. The Desana people of Colombia use aroma in exchange rituals and as a basis for identity (Classen, 1990). Observations that the Tsimane people from the Bolivian rainforest are able to perceive odours at a lower threshold than a cohort of Western people from Germany led to speculation that the observed differences could be environmentally induced, learned or genetic (Sorokowska et al., 2013). However, studies of odour perception in Malay Indigenous populations provide evidence that cultural learning underpins odour lexicons and olfactory capability. The value of odour to the Maniq people of Southern Thailand is underpinned by the development of an odour lexicon not observed in Western languages (Wnuk and Majid, 2014). Many of the words used by the Maniq people relate to food and show an ability to determine the safety of food items. A more recent study has shown significant differences in odour lexicons and the ability to name individual odours between two related Malay tribes with different lifestyles (hunter-gatherer versus swidden horticultualists) (Majid and Krupse, 2018). Olofsson and Wilson (2018) have speculated, in response to this study, that 'active olfactory training or cultural imposition may not only shape olfactory language but actually shape odor perception' (p. R109).

These examples highlight the importance of both the biological and the social in thinking about visceral engagement with food and suggest that flavour training which includes an olfactory component may have benefits with regard to people's ability to form new associations with healthy food, either by active training or simply 'mere exposure' as described by (Majid et al., 2017). The value of including aroma as a component of processes which teach people to engage with healthy food is further underpinned by the unique link of aroma perception to memory and emotion. There is an assumption amongst horticulturalists that when provided with more flavoursome fruits and vegetables through selecting for varieties that have richer flavour characteristics the consumer will be exposed to, and prefer, these new varieties in comparison with less healthy food alternatives (Kader, 2008; Klee 2010). However, without the capacity to discriminate between flavours and given that people have learned an emotional association with particular flavours, perhaps 'mere exposure' should not be assumed to be sufficient to change eating preferences.

The reflective process used by the Altered Eating Research Network's 'food play' methodology (Burges Watson et al., 2019) may be one approach through which to reflect on the biosociality of food and eating and to encourage new food associations. Food play is defined as a 'hands-on experience of food preparation, sharing and 'tasting opportunities' (where tasting is not essential to involvement) in a commensal setting where the research focus is co-produced with participants' (p.140). The methodological approach was developed through patient and public involvement led research with survivors of head and neck cancer, a patient group who may experience complex eating difficulties and a range of sensory and functional deficits. The authors argued that 'food play' animates engagement because the experience of eating together with others created 'highly differentiated narratives' of the same food encounter, whereby visceral difference became the 'group norm'. The approach could be applied more broadly in order to reflect on visceral difference and its biosocial

origins, for participants to experience greater flavour richness and diversity and to introduce smell training.

Activities with a focus on food play and the expansion of flavour perception might provide a range of health and wellbeing benefits beyond those for people with illness related altered eating difficulties. Such programs may offer an opportunity to develop an awareness through the senses of the flavour differences between ultra-processed foods and 'healthier' alternatives. Use of sensory education that draws on models such as the 'Sapere' method, although not extensively trialled, include studies shown to increase children's willingness to eat berries and vegetables (Hoppu et al, 2015). Other studies that support a sensory / flavour focus include a French study which reported that some respondents had pleasure related wellbeing outcomes that were associated with the flavour of food (Guillemin et al., 2016). Marty et al (2018) reviewed a range of studies which indicated that the sensory characteristics of food are an aspect of the pleasure associated with eating in children. The focus on 'pleasure' has also been emphasised by Vogel and Mol (2014) as an alternative to weight loss programmes that emphasise cognitive 'control' of diet. In their research, the visceral experience of pleasure may be denied by such cognitive approaches whilst fostering the development of 'feeling what you need' can help reframe and draw attention to the bodily experience of needs versus desires.

Another aspect of flavour training could relate to promoting community gardening and foraging activities. Urban foraging is known to be widespread across the globe (Shackleton et al., 2017), and it has been estimated that more than 100 million EU citizens forage 'wild foods' (Schulp et al., 2014). Research has considered foraging in relation to food insecurity, economic value and contributions to urban agriculture, identity and place (McLain et al., 2014; Murray and Simcox, 2003; Poe et al., 2014). However, to our knowledge, no research has addressed why and whether foraging is a popular from a sensory point of view. Human - nature interactions, the loss of which have been reported to negatively impact human health and wellbeing (Cox and Gaston, 2018), provided by participation in urban agriculture and foraging activities could free people from their learned food associations and thus provide a range of health and wellbeing outcomes.

Conclusion

This paper proposes that flavour is a critical part of agency in food and eating considerations. It questions whether a focus on the broader assemblage of political rationales for why we engage with food and foodscapes take us further away from the vital materiality and agency inherent in more-than-food considerations? Could a greater focus on flavour encourage people to engage more broadly with AFNs such as urban agriculture and foraging? Can we bring food back to a simple corporeal materiality that reflects on our biosocial engagement with food and foodscapes through flavour? Could this awareness build on the biosociality of that engagement and broaden the possibilities for experiencing difference beyond the high, salt, and sugar palatability of diets encouraged by ultra-processing?

The experience of flavour is mediated by complex biosocial mechanisms through which we learn, experience pleasure, and viscerally engage with food and foodscapes. At the biological level the flavour of food is an integrated multi-modal sensory process within which aroma is a key component that is, linked neurologically to emotion and memory. The biological mechanisms of flavour perception can be disrupted by pollution and illness leading to sensory inequities. However, flavour and related food preferences are strongly linked to social mechanisms including learned abilities to distinguish flavour aspects and associations with particular foods that can be learned in childhood and which have the capacity for change over the life-course.

The dominance of 'big food', in particular the emergence of ultra-processed food, has been highlighted in terms of the ways in which there has been a distanciation from flavour and the source of food, the links to NCDs, and because these foods anesthetise consumers to the experience of diverse flavours. Importantly, through the case study of beer, we have mapped in some detail how the flavour of food and beverages can be transformed and diminished through a combination of technological and social processes that become locked in and resistant to change. Ironically, the beer example demonstrated the possibility that science and technology may have a role in unlocking flavour experiences for consumers. Alternative food networks are proposed as a potential antidote and response to these concerns with 'big food' whilst addressing concerns that suggest these movements may promote a 'correct' way of eating.

The source of food and inherent flavour together with the capacity for visceral experience and its link to place deserves further consideration by scholars. Pollution and exposure to 'fast food' are clearly socio-economically and geographically patterned; other influences such as illness and life-course transitions may also have place-associations. In short, flavour inequalities and inequities may impact on people's food preferences, and this may be important in addressing the current perceived limitations of AFNs.

Visceral geography attends to the biosocial and embodied experience of food and eating and asks how visceral methods might be used to 'trace' the environment into the body and body into the environment (Hayes-Conroy, 2017). This examination of the importance of flavour in food and eating demonstrates that a focus on flavour has the potential to be transformative in the way we think about the relationship between food and the body, and provide new methodologies for visceral geography. Desire for flavour drove the craft beer industry to the point where it is challenging and transforming the large beer companies. A deeper understanding of flavour represents a unique but unexplored capacity within AFNs to transform engagement with food and foodscapes. AFNs may have a role in helping people understand and reflect on their visceral relationship to food that moves beyond either 'mere exposure' to alternative foods and / or 'simply thinking' about them as healthy options. Future research regarding the role of AFNs in exploring the link between flavour and food preferences would be useful.

Understanding the importance of the olfactory sense as a component of flavour, through the link to memory and emotion and the wide biosocial mechanisms that might drive olfactory perception, provides a means to understand visceral engagement with food, particularly visceral differences. Flavour-based relational activities could broaden people's understanding of why and how food preferences are shaped and contribute to deeper reflection on the contribution of flavour to well-being. A flavour based 'source to senses' approach to visceral geography is proposed.

Acknowledgements

The authors would like to thank Prof Mike Goodman, Prof Ted Schrecker and Dr Kara Hoover for comments on various drafts. We would also like to thank Prof Barry Smith for his conception and gift of the term ‘source to senses’. Thanks to Prof Anthony Koutoulis and Dr Evan Evans for comments and discussion over several years regarding the factors which influence the flavour of beer.

Authorship

Both authors contributed equally to this manuscript.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of conflicting interests

The Authors declare that there is no conflict of interest.

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